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(54) **Glass window antenna for motor vehicle.**

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EP-A- 0 346 591
PATENT ABSTRACTS OF JAPAN vol. 10, no. 184 (E-415)(2240) 27 June 1986, & JP-A-61 30102 (NIPPON SHEET GLASS) 12 February 1986,
PATENT ABSTRACTS OF JAPAN vol. 13, no. 268 (E-775)(3616) 20 June 1989, & JP-A-01 57802 (CENTRAL GLASS) 06 March 1989,

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Description

This invention relates to a glass antenna for a motor vehicle, more particularly, to a glass window antenna which applies reception power to a receiver in a diversity reception system.

Reception conditions vary in accordance with movement of reception point when an FM or TV broadcast wave is received by a traveling motor vehicle. A space diversity reception system using a plurality of antenna elements is employed to prevent the quality of a radio voice or a TV picture from being degraded by the variation of the reception field. It is known to constitute these antenna elements for diversity reception with glass window antennas formed of conductors printed on a window glass of the motor vehicle (refer to, for example, Japanese patent application laid-open No. 203702/1986).

Document EP-A-0 297 328 discloses several antennas assigned to several reception bands on a single vehicle window where the heater conductors are also used as antenna conductors.

Document PATENT ABSTRACTS OF JAPAN, vol. 13, no. 268 (E-775)(3616) 20 June 1989 & JP-A-01 57802 discloses an antenna conductor in the non-defogging area which is inserted as an intermediate layer in a laminated window.

Document EP-A-0 346 591, published after the priority date of the present application, and relevant according to Articles 52 and 54 (3) EPC, discloses an antenna with two antenna conductors situated respectively outside and inside the defogging area. The second conductor extends to cross the heater wires. However, the two conductors are not assigned to two differing reception bands, and are situated on a same surface of the laminated window.

A glass window antenna is usually arranged on a rear glass window for convenience to keep the field of view of the front windshield clear as well as ameliorating the problem of wiring between the antenna and a receiver.

The space available in which to arrange the antenna conductor is however limited to the upper or lower blank portion outside the middle area where defogging heater wires are attached by printing. It is not possible to provide many antenna conductors on a glass window having small blank areas. In particular, a small-sized automobile has an upright rear window with less blank area to arrange necessary antenna conductors thereon. Moreover, when many antenna conductors are arranged in the blank portion, they must have simple configuration with few constituent elements. It restricts tuning factors of reception directivity and bandwidth.

Accordingly, it is an object of this invention to arrange antenna conductors having high efficiency for diversity reception on a limited area of glass window.

It is another object of this invention to provide arrangements of antenna conductors which can be incorporated with a space and frequency diversity reception system.

A window glass antenna for a motor vehicle according to this invention comprises a group of heater wires provided in a defogging area on the inside surface of a laminated window glass consisting of an inner glass and an outer glass; a first antenna conductor arranged out of said defogging area on the inside surface of the inner glass; a second antenna conductor inserted into an intermediate layer of the laminated glass and extending to cross the heater wires; and a coupling member to couple said first and second antenna conductors for constituting a single synthesized antenna; the first antenna conductor being assigned to a lower reception band and said second antenna conductor being assigned to an upper reception band.

The first antenna conductor shows sufficient gain with a relatively simple conductor pattern since it is limited to reception of lower reception band, though conductors are hard to pattern into a complex form for tuning on a narrow blank area. The second antenna conductor is insulated from the heater wires by glass so that the conductor can be a vertical element crossing the heater wires. A vertical element mounted on a motor vehicle can be easily tuned in higher frequency band.

The synthesized antenna consisting of the first and second antenna conductors coupled with each other has good reception characteristics over a wide frequency range. An antenna system which effectively uses a narrow space on the window glass is obtained.

The above, and other, objects, features and advantages of the present invention, will become readily apparent from the following detailed description thereof which is to be read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view of a rear glass window showing one embodiment according to this invention;
Fig. 2 is a front view of an inner glass having conductors arranged inside thereof;
Fig. 3 is a front view of an outer glass showing wire antennas arranged inside thereof; and
Fig. 4 is a cross-sectional view showing connecting feature of a feeding portion.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Fig. 1 is a front view of a rear window glass showing an embodiment of glass window antenna of a motor vehicle according to this invention. The rear glass window 1 is formed of a laminated glass consisting of

an inner glass 2 and an outer glass 3 which are put together with an interlayer 4 formed of a transparent synthetic resin film interv ning thereb tween.

A lot of heater wires 5 are arranged in a defogging area located in the central portion of the rear glass window 1. The heater wires 5 are supplied with power to remove fog on the glass surface from bus bars 6 and 7 at one end of the heater wires 5 which are connected by a bus bar 8 at their other end. These bus bars 6, 7 and 8 and the heater wires 5 are formed on the inner glass 2 by printing silver paste or the like on the inner surface thereof and baking thereafter, as shown in Fig. 2 illustrating a front view of the inner glass.

Antenna conductors are arranged on the same surface on which the heater wires are attached, that is, inside the inner glass 2, in upper and lower blank areas outside the defogging area. The antenna conductors are formed by printing conductive paste. On the relatively large upper blank area, a main antenna 10 is arranged to receive AM/FM broadcast waves.

The main antenna 10 comprises horizontal elements 10a and 10b extending horizontally from a feed terminal 11 located at left side portion of the glass and then folded to turn at right side portion, a horizontal element 10c connected through a connecting element 10d to a tuning point located at a position displaced from the center of the element 10a, a horizontal element 10e shaped into letter-L and extending from the feed terminal 11 closely alongside the element 10c, and a horizontal element 10g connected to the center of the element 10b through a connecting element 10f. A horizontal element 5a is arranged parallel and close to the element 10g. The center of the element 5a is connected to the center of the uppermost heater wire 5 through a connecting element 5b so that induced broadcast frequencies (mainly AM frequencies) on the heater wires 5 are transferred to the AM/FM main antenna 10.

An FM subantenna 12 consisting of two parallel horizontal element 12a and 12b about 400 mm and 200 mm long is provided on the left side of the lower blank area. Reception power induced on the subantenna 12 is derived from an FM feed terminal 13 located below the bus bar 13.

Reception outputs at the feed terminals 11 and 13 of the main antenna 10 and subantenna 12 are fed to an FM diversity receiver through feeder cables 26 and 27. AM reception output of the main antenna 10 is fed to an AM receiver from the feed terminal 11 through cable 26.

The diversity receiver is adapted to receive TV broadcast frequency. First to fourth TV feed terminals 14-17 are provided insid the inner glass 2 to feed TV r ception power. A masking 9 is provided along the edges of the window glass 1 with a width sufficient for concealing the bus bars 6, 7 and 8 and the feed terminals 11, 13 14 - 17 from the outside of the motor vehicle.

The first TV feed terminal 14 is provided on the bus bar 8 to fe d TV reception signal induced on th heater wires 5. An auxiliary elem nt 5c is xtended from an end portion of the uppermost heater wire 5 to compensate for the reception characteristics of the heater wires 5, which are utilized as the first TV antenna.

A second TV antenna 20 is coupled to a second feed terminal 15 which is located below the bus bar 8. The second TV antenna 20 comprises a horizontal element 20a printed inside the inner glass, and a horizontal element 20c connected by an element 20b to the second feed terminal 15 to extend closely parallel with the lowermost heater wires 5. These elements 20a and 20c are respectively 500 mm and 200 mm in length and are tuned in lower band of TV broadcast wave.

The second TV antenna 20 further comprises a wire antenna element 20d arranged to cross the heater wires 5 so as to have a vertical component. The wire antenna element 20d is formed of a metal wire having a diameter of about 0.13 mm which is provided inside the outer glass 3 so as to be put between the outer glass 3 and the interlayer 4, as shown in Fig. 3 illustrating a front view of the outer glass 3. The wire antenna element 20d is therefore insulated from the heater wires 5 with the inner glass 2 and the interlayer 4 as shown in a cross-sectional view of Fig. 4. The wire antenna element 20d is about 300 mm in length and has a vertical component which effectively receives a higher band of TV broadcast frequencies. As there is less capacitive coupling between the wire antenna element 20d and the heater wires 5, the wire antenna has less degradation of its reception characteristic in the higher band.

As shown in the cross-sectional view of Fig. 4, the wire antenna element 20d in the intermediate layer is coupled to the feed terminal 15 arranged inside the inner glass 2 through a copper thin plate 23 fixed by solder 25. A wide-band synthesized reception signal consisting of a low band component and a high band component is obtained at the feed terminal 15 respectively from the horizontal elements 20a and 20c and the wire antenna element 20d. The coupling portion by the copper thin plate 23 is covered with a resin seal 24.

Two long and short wire antenna elements 21 and 22 are inserted inside the outer glass 3 to extend vertically along left side thereof. The long wire antenna element 21 is utilized as a third TV antenna which has a length l_2=600 mm and is tuned in a lower band (1-3 channels) of VHF-TV broadcast frequencies.

The short wire antenna element 22 is utilized as a fourth TV antenna which has a length l_3=400 mm and is tuned in a higher band (4-12 channels) of VHF-TV broadcast fr qu ncies.

The lower end of the wir antenna element 21 and

the upper end of the wire antenna element 22 are respectively extended to a sid edge of the outer glass 2 and then connected to th third and fourth f ed terminals 16 and 17 located inside the inner glass 2 through the same connecting arrangement as that shown in Fig. 4.

The TV reception signals obtained at the first to fourth feed terminals 14 - 17 are supplied to a TV tuner of the diversity reception system.

In the above-mentioned embodiment, the wire antenna elements 20d, 21 and 22 may be formed of printed conductors.

According to the invention, the first antenna conductor 20a and 20c arranged in the blank area outside the area of the heater wires 5 is restricted to exclusive use in a lower reception band so that it can be tuned to have a high gain even in a narrow space on the glass. A sufficient reception gain is obtained over a wide range with a synthesized output generated by the first antenna conductor and the second antenna conductor 20d which is tuned for exclusive use in the higher band. The second antenna conductor 20d can be a vertical element crossing the heater wires 5 so that it can be easily tuned for use in the higher band. In particular, the second antenna conductor 20d shows a good reception characteristic in a high frequency range as it has less capacitive coupling with the heater wires.

Diversity reception is performed with signals consisting of the reception outputs of antenna conductors 21 and 22, the reception output of the heater wires 5 and the reception output of the synthesized antenna. Good reception characteristics are obtained by using several antenna elements even in a case where areas for the antenna conductors on a window glass is restricted.

Claims

1. A glass window antenna for a motor vehicle having a group of heater wires provided in a defogging area on the inside surface of a laminated window glass consisting of an inner glass and an outer glass, characterized by comprising:

   a first antenna conductor (20a, 20b, 20c) arranged out of said defogging area on the inside surface of the inner glass (2);

   a second antenna conductor (20d) inserted into an intermediate layer (4) of the laminated glass (2, 3) and extending to cross the heater wires (5); and

   a coupling member (23) to couple said first and second antenna conductors for constituting a single synthesized antenna (20),

   said first antenna conductor being assign d to a lower reception band and said second antenna conductor being assigned to an upp r reception band.

2. A glass window antenna according to claim 1, characterized in that a feed terminal (15) of said synthesized antenna (20) is formed on the inside surface of said inner glass (2).

3. A glass window antenna according to claim 2, characterized in that said first antenna conductor comprises a single horizontal conductor (20a) extending from said feed terminal (15) and a horizontal conductor (20c) extending closely alongside the heater wires (5) to collect induced reception power from said heater wires.

4. A glass window antenna according to claim 1, characterized by further comprising a third antenna conductor (21) inserted into the intermediate layer (4) of the laminated glass (2, 3) and extending to cross the heater wires (5) in a lateral side area different from the area where said synthesized antenna (20) is arranged,

   an output of said third antenna conductor being derived for diversity reception together with the output of said synthesized antenna.

5. A glass window antenna according to claim 4, characterized in that said third antenna conductor comprises two independent antenna conductors (21, 22) consisting of a long, single line conductor (21) and a short, single line conductor (22) respectively connected to different feed terminals (16, 17).

6. A glass window antenna according to claim 5, characterized in that said feed terminals (16, 17) of said third antenna conductor (21, 22) are located respectively on the inside surface of upper and lower portions of said inner glass (2),

   said long and short line conductors (21, 22) extending in opposite direction to each other to cross said heater wires (5) and said line conductors being respectively connected to the corresponding feed terminals (16, 17) through connecting members (23).

7. A glass window antenna according to claim 4, characterized by further comprising a fourth antenna conductor employing said heater wires (5), reception outputs by said synthesized antenna (20), said third antenna conductor (21, 22) and said fourth antenna conductor (5, 5c) being derived to a diversity reception system.

8. A glass window antenna according to claim 7, characterized in that said fourth antenna conductor comprises said heater wires (5) and an auxiliary, horiz ntal antenna conductor (5c) formed n

th inside surface of the inner glass and connected to said heater wires to extend from the side area of the laminated glass wher said synthesized antenna (20) is located.

9. A glass window antenna according to claim 5, characterized in that said first and second antenna conductors (20a, 20b, 20c) are assigned respectively to a lower band and an upper band of a TV broadcast band and said short and long line conductors (21, 22) are assigned respectively to a upper band and a lower band of the TV broadcast band.

10. A glass window antenna according to claim 9, characterized by further comprising an antenna conductor (10) provided outside the defogging area on the inside surface of the inner glass (2) of the laminated glass for reception of a radio broadcast wave.

Patentansprüche

1. Scheibenantenne für ein Kraftfahrzeug, mit einer Gruppe von Heizdrähten in einem Entnebelungsbereich an der inneren Oberfläche einer schichtförmig aufgebauten Fensterscheibe, bestehend aus einer inneren Scheibe und einer äußeren Scheibe, **gekennzeichnet durch**
   - einen ersten Antennenleiter (20a, 20b, 20c) außerhalb des Entnebelungsbereichs an der inneren Oberfläche der inneren Scheibe (2);
   - einen zweiten Antennenleiter (20d) auf einer Zwischenschicht (4) der schichtförmig aufgebauten Scheibe (2, 3), der sich quer zu den Heizdrähten (5) erstreckt; und
   - ein Kopplungselement (23) zur Verkopplung von erstem und zweitem Antennenleiter zwecks Bildung einer einzigen, synthetischen Antenne,
   - wobei der erste Antennenleiter einem unteren Empfangsband und der zweite Antennenleiter einem oberen Empfangsband zugeordnet sind.

2. Scheibenantenne nach Anspruch 1, **dadurch gekennzeichnet**, daß sich ein Zuleitungsanschluß (15) der synthetischen Antenne (20) auf der inneren Oberfläche der inneren Scheibe (2) befindet.

3. Scheibenantenne nach Anspruch 1, **dadurch gekennz ichnet**, daß der erst Antennenleiter inen inzeln n Horizontalleiter (20a), d r vom Zul itungsanschluß (15) ausgeht, sowie einen Horizontalleiter (20c) aufweist, der sich in d r Nähe und entlang der Heizdrähte erstr ckt, um induzierte Empfangsleistung von den Heizdrähten aufzufangen.

4. Scheibenantenne nach Anspruch 1, **gekennzeichnet durch** einen dritten Antennenleiter (21) auf der Zwischenschicht (4) der schichtförmig aufgebauten Scheibe (2, 3), der sich quer zu den Heizdrähten (5) in einem Seitenbereich erstreckt, welcher sich von demjenigen Bereich unterscheidet, in welchem die synthetisierte Antenne (20) vorhanden ist, wobei ein Ausgang des dritten Antennenleiters für den weiteren Empfang zusammen mit dem Ausgang der synthetisierten Antenne erhalten wird.

5. Scheibenantenne nach Anspruch 4, **dadurch gekennzeichnet**, daß der dritte Antennenleiter zwei unabhängige Antennenleiter (21, 22) aufweist, nämlich einen langen Einzelleiter (21) und einen kurzen Einzelleiter (22), die jeweils mit einem anderen Zuführungsanschluß (16, 17) verbunden sind.

6. Scheibenantenne nach Anspruch 5, **dadurch gekennzeichnet**, daß sich die Zuführungsanschlüsse (16, 17) des dritten Antennenleiters (21, 22) an der inneren Oberfläche der inneren Scheibe (2) zum einen im oberen Bereich und zum anderen im unteren Bereich befinden, wobei sich der lange Leiter und der kurze Leiter in entgegengesetzter Richtung zueinander und quer zu den Heizdrähten (5) erstrecken, und wobei ferner diese linienartigen Leiter mit den jeweiligen Zuführungsanschlüssen (16, 17) über Verbindungselemente (23) verbunden sind.

7. Scheibenantenne nach Anspruch 4, **gekennzeichnet durch** einen die Heizdrähte (5) verwendenden vierten Antennenleiter, wobei durch die Empfangsausgänge von synthetisierter Antenne (20), drittem Antennenleiter (21, 22) und viertem Antennenleiter (5, 5c) ein Mehrempfangssystem erhalten wird.

8. Scheibenantenne nach Anspruch 7, **dadurch gekennzeichnet**, daß der vierte Antennenleiter die Heizdrähte aufweist sowie einen horizontalen Hilfsantennenleiter (5c) an der inneren Oberfläche der inneren Scheibe, der mit den Heizdrähten verbunden ist und sich von derjenigen Seite des Glaslaminats aus erstreckt, an der die synthetisierte Antenne (20) vorhanden ist.

9. Scheibenantenn nach Anspruch 5, **dadurch gekennz ichnet**, daß der erste und d r zweite Antennenleiter (20a, 20b, 20c) jeweils inem unteren Band und inem oberen Band eines TV-Rundfunkbandes zugeordnet sind, und daß fer-

ner der kurz und der lange Linienl iter (21, 22) jew ils einem oberen Band und einem unter n Band des TV-Rundfunkbandes zugeordn t sind.

10. Scheibenantenne nach Anspruch 9, **gekennzeichnet durch** einen Antennenleiter (10) außerhalb des Entnebelungsbereichs an der inneren Oberflache der inneren Scheibe (2) des Glaslaminats zum Empfang einer Radio-Rundfunkwelle.

Revendications

1. Antenne pour fenêtre vitrée de véhicule à moteur possédant un groupe de fils chauffants disposés dans une zone de désembuage sur la face interne d'une vitre de fenêtre en verre feuilleté constituée d'une vitre intérieure et d'une vitre extérieure, caractérisée en ce qu'elle comprend :

un premier conducteur d'antenne (20a, 20b, 20c) disposé hors de ladite zone de désembuage sur la face interne de la vitre intérieure (2) ;

un deuxième conducteur d'antenne (20d) inséré dans une couche intermédiaire (4) de la vitre en verre feuilleté (2, 3) et s'étendant de façon à croiser les fils chauffants (5) ; et

un élément de couplage (23) servant à coupler lesdits premier et deuxième conducteurs d'antenne afin de constituer une unique antenne synthétisée (20),

ledit premier conducteur d'antenne étant affecté à une bande de réception inférieure et ledit deuxième conducteur d'antenne étant affecté à une bande de réception supérieure.

2. Antenne pour fenêtre vitrée selon la revendication 1, caractérisée en ce qu'une borne d'alimentation (15) de ladite antenne synthétisée (20) est formée sur la face interne de ladite vitre intérieure (2).

3. Antenne pour fenêtre vitrée selon la revendication 2, caractérisée en ce que ledit premier conducteur d'antenne comprend un unique conducteur horizontal (20a) s'étendant depuis ladite borne d'alimentation (15) et un conducteur horizontal (20c) s'étendant le long des fils chauffants (5) à proximité de ceux-ci afin de recueillir la puissance de réception induite venant desdits fils chauffants.

4. Antenne pour fenêtre vitrée selon la revendication 1, caractérisée en c qu' lle comprend en outre un troisième conducteur d'ant nne (21) inséré dans la couche intermédiaire (4) de la vitre en verre feuilleté (2, 3) t s'étendant de façon à crois r les fils chauffants (5) dans une zone du côté latéral, qui est différente de la zone où st disposée ladite antenne synthétisée (20),

un signal d sorti dudit troisièm conducteur d'antenne étant obtenu en vue d'une réception en diversité en même temps que le signal de sortie de ladite antenne synthétisée.

5. Antenne pour fenêtre vitrée selon la revendication 4, caractérisée en ce que ledit troisième conducteur d'antenne comprend deux conducteurs d'antenne indépendant (21, 22) consistant en un unique conducteur linéaire long (21) et un unique conducteur linéaire court (22) respectivement connectés à des bornes d'alimentation différentes (16, 17).

6. Antenne pour fenêtre vitrée selon la revendication 5, caractérisée en ce que lesdites bornes d'alimentation (16, 17) dudit troisième conducteur d'antenne (21, 22) sont respectivement placées sur la face interne de parties supérieure et inférieure de ladite vitre intérieure (2),

lesdits conducteurs linéaires long et court (21, 22) s'étendant dans des sens mutuellement opposés de façon à croiser lesdits fils chauffants (5), et lesdits conducteurs linéaires étant respectivement connectés aux bornes d'alimentation correspondantes (16, 17) via des éléments de connexion (23).

7. Antenne pour fenêtre vitrée selon la revendication 4, caractérisée en ce qu'elle comprend en outre un quatrième conducteur d'antenne employant lesdits fils chauffants (5), les signaux de sortie de réception délivrés par ladite antenne synthétisée (20), ledit troisième conducteur d'antenne (21, 22) et ledit quatrième conducteur d'antenne (5, 5c) étant fournis à un système de réception en diversité.

8. Antenne pour fenêtre vitrée selon la revendication 7, caractérisée en ce que ledit quatrième conducteur d'antenne comprend lesdits fils chauffants (5) et un conducteur d'antenne horizontal auxiliaire (5c) qui est formé sur la face interne de la vitre intérieure et est connecté auxdits fils chauffants de façon à se prolonger depuis la zone latérale de la vitre en verre feuilleté où ladite antenne synthétisée (20) est placée.

9. Antenne pour fenêtre vitrée selon la revendication 5, caractérisée en ce que lesdits premier et deuxième conducteurs d'antenne (20a, 20b, 20c) sont respectivement affectés à une bande inférieure t à une band supérieure d'une bande d diffusion d télévision, et l sdits conducteurs linéaires court et l ng (21, 22) sont respectivement affectés à une bande supérieur et à une band

inférieure de la bande de diffusion de télévision.

10. Antenn pour f nêtre vitré s lon la revendication 9, caractérisée en ce qu'elle comprend en outre un conducteur d'antenne (10) placé à l'extérieur de la zone de désembuage sur la face interne de la vitre intérieure (2) de la vitre en verre feuilleté en vue de la réception d'une onde de radiodiffusion.

FIG. 1

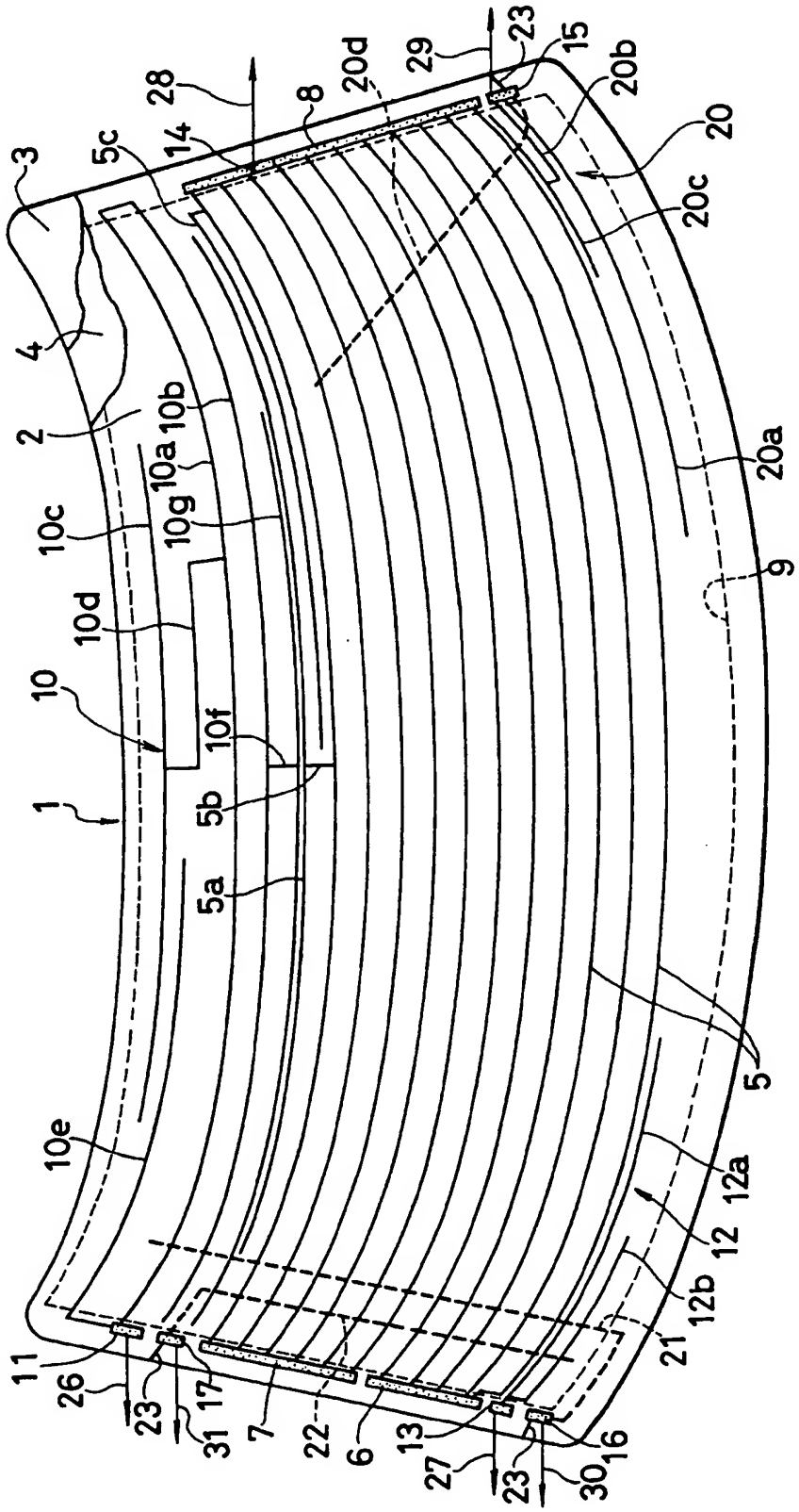
28
8
20d
29
23
15
20b
20
3
5c
14
20c
4
2
10b
10a
10g
20a
10c
9
10d
10
10f
1
5b
5a
5
10e
12a
12
12b
21
11
26
23
17
31
7
22
6
13
27
23
30
16

FIG. 2

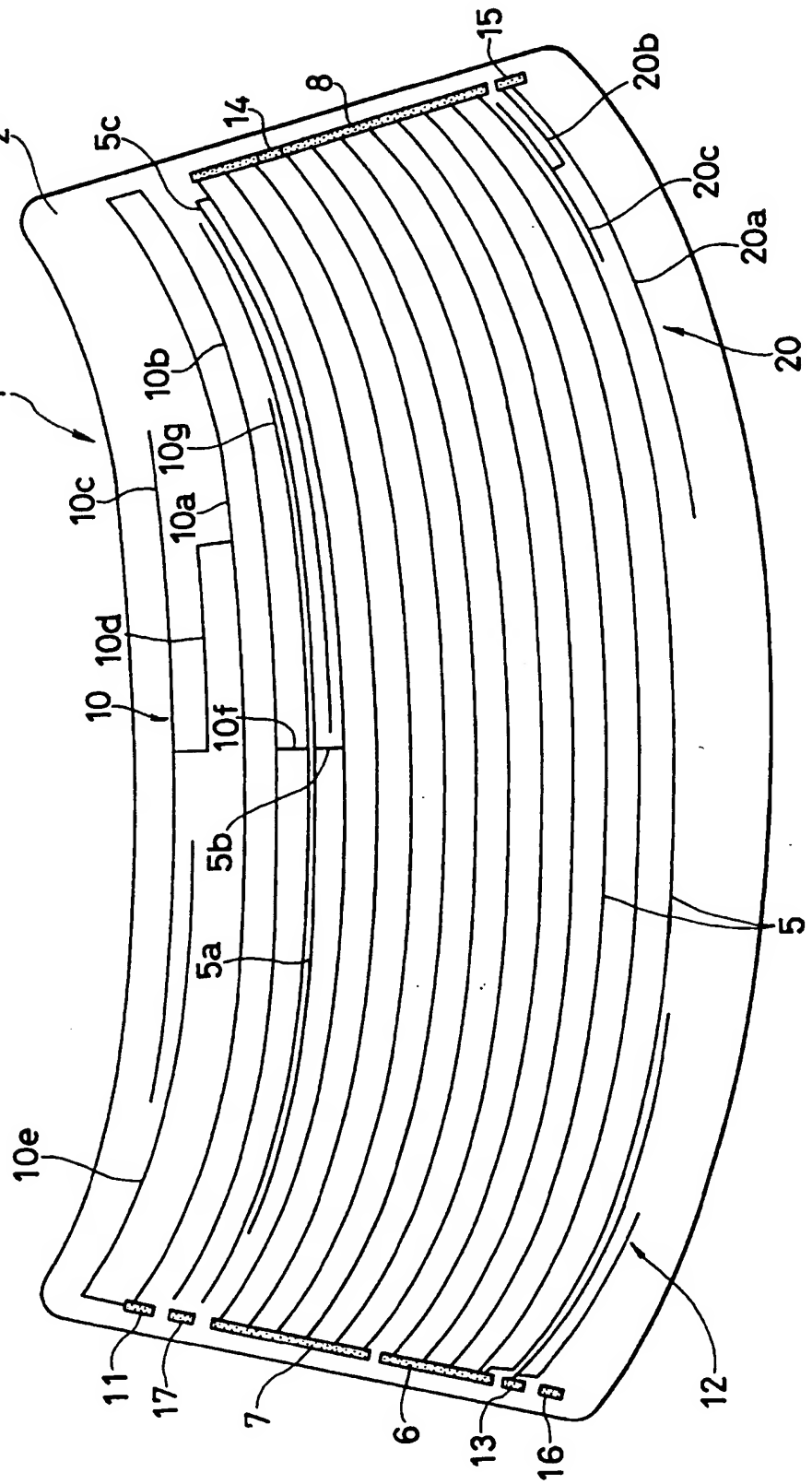
15
20b
8
14
5c
2
20c
20a
20
1
10b
10g
10c
10a
10d
10
10f
5b
5a
5
10e
11
17
7
6
13
16
12

FIG. 3

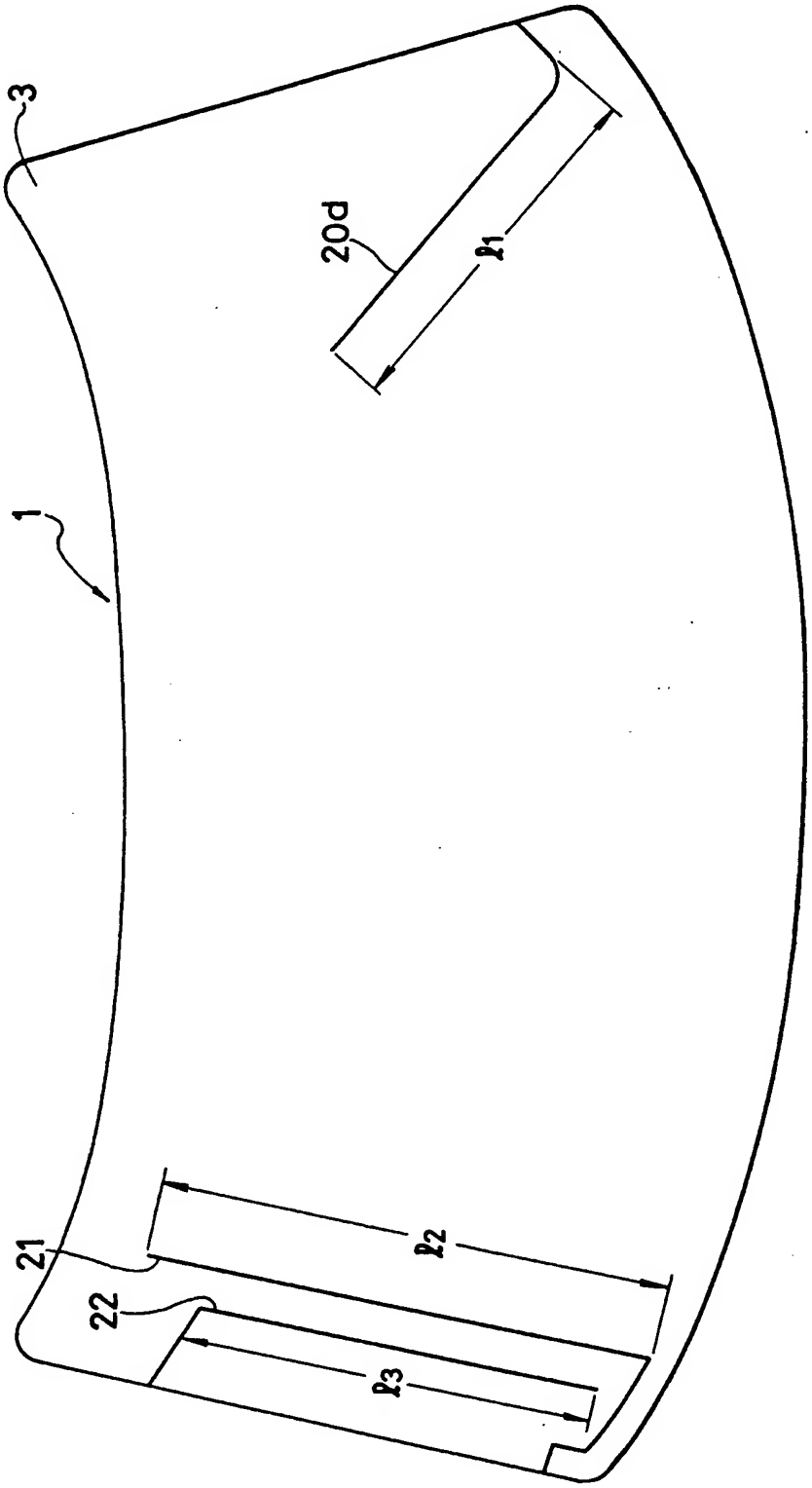

FIG. 4